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B8 #1

A Contribution to the Chemistry of Butter-fat.

III. The Chemistry of Rancidity in Butter-fat.

By C. A. Browne, Jr.

X-S 585
.B8 #2

The Chemical Analysis of the Apple and Some of its Products.

By C. A. Browne, Jr.

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.B8 #3

The Complete Analysis of Feeding Materials.

By C. A. Browne, Jr., and C. P. Beistle.

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.B8 #1

C. A. Browne

A Contribution to the Chemistry of Rice Oil.

By C. A. Browne, Jr.

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The Effects of Fermentation upon the Composition of Cider and Vinegar.

By C. A. Browne, Jr.

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The Hydrolytic Products of Sugar-Cane Fiber.

By C. A. Browne, Jr.

X-S 585
.B8#7

C. A. Browne

THE PENNSYLVANIA STATE COLLEGE
AGRICULTURAL EXPERIMENT STATION.

STUDIES UPON

THE

COMPOSITION

OF

TIMOTHY HAY.

(With Notes upon the Chemistry of Grasses.)

By Wm. Frear, W. T. Carter, C. A. Browne, Jr. R. O. Brooks
and C. W. Norris.

(*Reprint from the Annual Report for 1903-4.*)

WM. STANLEY RAY,
STATE PRINTER OF PENNSYLVANIA,
1905.

X-S 585
.88 #8

The Analysis of Sugar Mixtures.

By C. A. Browne, Jr.

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.B8

X-S 585 B8 #9

VI CONGRESSO INTERNAZIONALE DI CHIMICA APPLICATA

Roma 1906

Comunicazione fatta nella Sezione V (Industria e chimica dello zucchero)

X-S 585
.B8 #10

The Use of Temperature Corrections in the Polarization of Raw Sugars and Other Products upon Quartz Wedge Saccharimeters.

By C. A. Browne.

X-S 585
B8 #1

The Normal Weight of Dextrose.

By C. A. Browne.

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.B8 #12

THE COMPARATIVE VALUE OF METHODS FOR ESTIMATING FAME

By C. A. BROWNE

[*Reprinted from* SCIENCE, *N. S., Vol. XXXIII., No. 855, Pages 770–773, May 19, 1911.*]

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.B8 #13

A Combination Specific Gravity Bottle and Dilatometer

By C. A. Browne

#14
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.B8

MANUFACTURE OF RAW SUGAR IN THE PHILIPPINE AND HAWAIIAN ISLANDS

BY

C. A. BROWNE

X-S 585
.B8 #15

The Limits of Accuracy in Saccharimetric Analysis.*

(*By C. A. Browne.*)

One of the most important questions in saccharimetry, as in other branches of analytical science, is that concerning the limits of accuracy in the final results. It is a question upon which there is the greatest diversity of opinion. Some chemists, for example, believe that it is a waste of time to strive for a greater accuracy in the laboratory than is obtained in sampling the product to be tested. In opposition to this view other chemists maintain that, since the work of sampling is controlled by chemical supervision, it is obviously wrong to reduce the standard of analytical science to a level conditioned in many cases by careless or unskilled labor; they take the more correct position that the accuracy of the analytical work should be kept at the highest possible efficiency regardless of the unfortunate lapses which may occur at times outside the laboratory.

From the economic standpoint the refinements of analysis need not be supposed to exceed the requirements of practical demands. These requirements of course differ in exactness according to the purposes of the analysis. A difference of 0.05 degree polarization, for example, is considered of vastly more importance in determining the selling price of a factory's output than in regulating certain matters of sugar-house control. No fixed rule can be established that will govern all cases, but looking at the question solely from the viewpoint of dollars and cents we are probably safe in following the refinements of analysis up to the point where the expense of the extra efforts towards accuracy begins to exceed the monetary value of the difference in valuation.

Saccharimetric measurements have at present reached a degree of exactness which was unimagined by early sugar analysts. It is significant to note in this connection that the Societé d'Encouragement pour l'Industrie Nationale in the program of a prize, which was offered 70 years ago in France for a commercial method of analyzing sugars, made the very modest stipulation that the means employed must determine the sugar content within two per cent. The saccharimeter of Soleil, which was soon afterwards described in a bulletin of the Societé d' Encouragement, far exceeded this requirement in exactness. This early instrument has now been so far improved that the sucrose content can be read to 0.05 per cent and even this, the generally accepted limit of accuracy, can be surpassed in case instrument makers are fortunate enough to obtain quartz crystals of the requisite purity or in case the chemist desires to correct his reading for the optical imperfections in the wedges of his instrument.

Accepting the figure 0.05 sugar degree as the limit of exactness with which the ordinary saccharimeter can be read the question arises whether the chemist should pay attention to errors of analysis which are less than this amount. As an example of such an error let us begin at the first step in sugar testing—the mixing of the sample previous to weighing out. We will use for illustration an actual case, that of an analyst who always mixes his sugars upon a sheet of newspaper. Upon being asked if there was not some danger of absorption of moisture by the paper from the sugar he replied that there was a slight absorption, but the amount was only a few hundredths of a per cent, so small, in fact, that the increase in polarization could not be detected on the polariscope so that the error was not worth considering.

The conclusion drawn by this chemist is characteristic of a deplorable attitude frequently assumed towards questions of commercial analysis—an attitude which finds its usual expression in some such remark as "the error is too small to be worth considering" or "the deviation is so slight that it cannot be measured." It is not difficult to show that the consequences of neglecting small and apparently insignificant errors in commercial analysis may become in certain cases exceedingly pernicious.

Let us suppose that the principle followed by the chemist in regard to the error of mixing be adhered to at every stage of sugar testing. Suppose the increase in polarization from the absorption of moisture by paper to be only 0.03 per cent; and suppose every other error at each stage of the analytical process to be this same "negligible" amount. What the total of such negligibles might amount to may be seen from the following tabulation:

TABLE I.

(Twelve Errors in Sugar Testing.)

1. Loss of moisture during mixing.
2. Loss of moisture during weighing.
3. Error in normal weights.
4. Volume of precipitate in clarification.
5. Precipitation of levulose in clarification.
6. Error in capacity of normal flasks.
7. Imperfect mixing of contents of flasks.
8. Evaporation during filtering.
9. Error in length of polariscope tubes.
10. Omission of bichromate cell.
11. Variations in temperature.
12. Defects in scales of saccharimeters.

If we suppose a plus error of only 0.03 from each one of the above causes, it is seen that the neglect of apparently insignificant errors, when followed as a consistent principle, may lead to a total plus error of 0.36 per cent. The plus error may even exceed this amount, as certain errors, such as those due to mixing moist sugars upon paper, to the volume of lead precipitate, to the omission of the bichromate cell and to the use of improper temperature corrections are often much greater than 0.03 sugar degree.

The objection may be raised that it rarely happens that the 12 errors enumerated in Table I all tend in the same positive direction; that while the final error is equal to the sum of the various individual errors, many of the latter

* Paper read before the New Orleans Section of the American Chemical Society, Nov. 20, 1914.

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·B8 #10

[Reprinted from the Journal of Industrial and Engineering Chemistry, Vol. 7, No. 1, page 30. January, 1915.]

THE INFLUENCE OF HYDROXY ACIDS AND LACTONES UPON DETERMINATIONS OF THE CHEMICAL CONSTANTS OF FATTY ACIDS

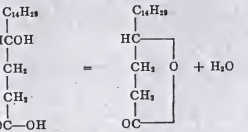
By C. A. Brown

Received October 6, 1914

The recent paper by Holland[1] upon "The Determination of the Acetyl Number of Oils, Fats, Etc.," recalls former discussions by Lewkowitsch, Benedikt and others regarding the value of the acetyl figure in the analysis of fatty acids. As the author has recently studied the determination of the acetyl number and other chemical constants in the insoluble acids of several decomposed butter fats, a few observations upon certain analytical data may possibly be of interest.

A serious difficulty, which often confronts the chemist in the analysis of fatty-acid mixtures, is the unstable character of the hydroxy-fatty acids. The latter, from their chemical behavior may be divided into two general classes: (1) the lactone-forming and (2) the non-lactone-forming hydroxy acids.

Lactone-forming hydroxy acids (more especially the γ acids) show a pronounced tendency, after being liberated, to form inner anhydrides. Thus γ-hydroxystearic acid, after separation from its salts or esters, passes immediately into stearo-lactone.



Hydroxy-stearic acid Stearo-lactone

The non-lactone-forming hydroxy acids, on the other hand, do not possess the property of yielding inner anhydrides. The hydroxyl group of this class of fatty acids remains unchanged and, in distinction from the hydroxyl group of the lactone-forming acids, is free to react with acetic anhydride during acetylation.

[1] This Journal, 6 (1914), 482.

X-S 585
'B8 #17

Reprint from The Louisiana Planter.

Problems in the Chemistry of Sugar.*

BY DR. C. A. BROWNE.

The province of sugar chemistry is to-day almost unlimited and in order to describe the problems that confront the chemist in this particular field within the limits of a single paper, it will be necessary to restrict the discussion of the topic, which has been assigned to me, to the one sugar sucrose. Even in case of this single sugar the various chemical problems upon the agricultural, technical, analytical and other sides are so numerous that our treatment must be limited to a brief survey of only a few phases of the subject, and with more special reference to the work of chemists in our own country.

One of the most interesting problems in the chemistry of sucrose, is the study of its occurrence and distribution in the vegetable kingdom. Plant physiologists a half century ago had begun to believe that sucrose was not limited in its occurrence to the cane, beet, maple and a few other commonly recognized sources; they began to suspect that if sensitive reagents could be found for its detection sucrose might prove to be one of the most widely distributed of plant substances. This suspicion was in large measure confirmed when Schulze and his coworkers, by means of their improved method of isolating minute quantities of sucrose in the form of its strontium compound, practically established the general distribution of sucrose not only in the various classes of green plants, but in all the organs of such plants. More recently the detection of sucrose by means of the enzyme invertase, in the hands of Bourquelot and other investigators, has greatly helped to widen our knowledge of the distribution of sucrose, and scarcely a month now passes, without the mention of some new plant in which this sugar has been discovered.

A closely related, but far more difficult, problem is the one concerning the function of sucrose in the economy of plant life. The role of sucrose as a reserve material in roots, stalks and fruits has, of course, long been recognized. But the part which sucrose plays in photosynthesis and in plant metabolism in general is very imperfectly understood. The flexible mechanism of the plant by which the simple hexose sugars are built up to sucrose or starch and these higher saccharides again broken down to hexoses furnishes such a continuous and perfectly balanced play of activities that its operation has been one of the most baffling problems of science. The law of osmotic equilibrium is, no doubt, the governing factor in this as in many other phenomena. According to this law the concentration of sucrose, starch and other higher carbohydrates, at any given point, whether in leaf or root, is simply the means which the plant adopts to lower the osmotic pressure at that point, the permissible degree of concentration increasing with the increase in molecular weight of carbohydrate. And so conversely the hydrolysis by enzymes of higher carbohydrates into those of lower molecular weight at any given point is the means adopted by the plant to increase the osmotic pressure at that point but the various steps in the process by which all these changes are produced remain to be worked out. The occurrence of transitory starch in the tissues of plants has been very minutely investigated; the problem of transitory sucrose is fully as important but before it can be solved there must be developed a good reliable micro-chemical test for sucrose. The importance of such a test will be appreciated when we consider that practically everything known about transitory starch has resulted from the micro-chemical test with iodine.

The effects of climatic and other conditions upon the sugar content of plants presents another class of interesting problems, and in this

*Paper read before the Section of Agricultural Chemistry of the American Association for the Advancement of Science, San Francisco, August 5, 1915.

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REPORT ON SUGAR

BY
C. A. BROWNE, *Referee*
(Sugar Trade Laboratory, New York, N. Y.)

REPRINTED FROM
THE JOURNAL OF THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS
VOL. II, NO. 2, NOVEMBER, 1916

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Reprint from
NEW YORK Sugar CHICAGO
For July. 1916.

The Recording of Laboratory Results in the Polarization of Raw Sugars

By C. A. Browne, Ph. D.,
Chemist in Charge, New York Sugar Trade Laboratory.

The system of records employed by the New York Sugar Trade Laboratory for rendering certificates of polarization to the buyers and sellers of raw sugar is of the simplest possible kind. The system was inaugurated at the establishment of the laboratory in 1907 and has continued with but few modifications up to the present time.

In order to illustrate the workings of this system we will follow the course of an imaginary transaction. John Doe has sold the Continental Sugar Co. 10,000 bags of raw sugar of the mark "Hesperia." This sugar is being delivered from the S. S. *Marne* at the Empire docks. Buyers and sellers have agreed to sample the cargo in four lots of 2,500 bags each. As the bags of sugar are unloaded and weighed the samplers for buyer and seller stab each bag at about the center with a trier, the sample of sugar which is removed being transferred to a covered bucket. When the first 2,500 bags have been sampled, the contents of the sample bucket are thoroughly mixed and six cans holding each about one pound of sugar are filled with the sugar. A label affixed to each can is made out according to Fig 1. A long strip, bearing the names of the sampler for buyer and seller and the date of sampling, is also pasted around the corner of the can as a seal. Of the six cans thus prepared, two cans are delivered to the buyers and two to the sellers, each of whom submit a can to their private chemist for polarization. The other two cans are delivered to the trade laboratory.

The cans of sugar as they are received at the trade laboratory are inspected, paired off and each pair given a serial number in the order as delivered, this number beginning with one at the commencement of each month. After numbering, one of the cans is sent into the laboratory for analysis; the duplicate can after copying the description upon the label into the record book is kept as a reserve in a sample closet for one month. A specimen page of the laboratory record book, which is of the loose leaf type, is shown in Fig. 2. Each sample is entered in the order of its serial number and in the work of the laboratory the chemists pay attention only to this number, the laboratory samples being mixed and polarized in numerical order.

After mixing the sample two chemists weigh out separate portions of 26,000 grms. each, these separate charges being then dissolved, clarified, made up to 100 c.c., filtered and polarized upon separate sacharizations of the two laboratory chemists differ by .05 degree, the custom of the trade laboratory is to give the benefit of the odd .025 degree to the buyer upon one day and to the seller upon the succeeding day. Thus the average of 96.00 and 96.05 would be reported to the trade as 96.05 today and as 96.00 tomorrow.

The Chemists' Record Sheets are one of the best guides as to the accuracy of the analytical work. The results of each chemist should fluctuate evenly above and below the average. If one chemist should begin to polarize always high or low, there is some defect in the routine which requires attention. The writer has shown on theoretical grounds that with a maximum variation of ±0.10 between two series of polarizations about 31 per cent of the readings should agree exactly, about 46 per cent should differ by ±0.05 and about 23 per cent should differ by ±0.10; these percentages correspond very closely to the results obtained by skilled analysts. Should the record sheets begin to show 30 per cent or more of the polarizations differing by ±0.10 for sugars of 96 polarization, some error is beginning to creep in which requires prompt correction.

After the readings of the two laboratory chemists are averaged, the record sheet of Chemist A is taken to the office and the polarization averages copied unto the record book according to serial number.

While the chemists of the laboratory are occupied with the work of polarizing, one of the clerks in the office fills out the certificates of polarization (Fig. 4) from the Laboratory Record Book. The loose leaf system enables one clerk to enter samples while another is engaged in copying certificates. When the certificates are filled out they are checked off by comparing them with the labels and numbers upon the sample cans sent into the laboratory.

If the certificates are properly made out the clerk proceeds to copy the polarization averages from the record book. When this is completed the polarization averages are checked back upon the record sheets

The writer makes usually about one lapse of this kind for every 500 readings and it is common with all chemists, especially when their attention becomes somewhat dulled by the strain of a long period of observations. It very rarely happens, however, that two chemists make the same mistake upon the same sample in recording their readings. If the liability of two chemists to write down the wrong reading is once in 500 readings, the chances of their writing down the wrong reading on the same sample is only once in 250,000 polarizations. It is thus seen that the chances of two chemists making the same observational error on the same sample of sugar are exceedingly remote. The chances of two skilled chemists making the same analytical error are almost equally distant. Should coincidences of error be of too frequent occurrence in a laboratory there is a lack of independence somewhere among the chemists.

Before the certificates of the Trade Laboratory are received the buyers and sellers have exchanged copies of their respective chemists' tests. As soon as the Trade Laboratory certificate arrives the three

VESSEL MARNE.....

Mark..Hesperia..... .....

Sample No...1....of...2500...pkgs.

Total in Mark...10,000..Bags.....

Buyer..Continent.. Sugar..Co..

Seller...John.Doe.... .....

Sampled at.Empire.Docks.....

DATE....4/10/10...851

Fig. 1—Form of label used by the New York Sugar Trade for marking samples. The number, 851, is the serial laboratory number for the month.

tests are compared and the average of the two nearest polarizations is taken for settlement. If the chemist for the Continental Sugar Co. found 96.10, the chemist for John Doe 96.30 and the Trade Laboratory found 96.25, the average of the last two polarizations, or 96.275, would be taken for settlement, the value 96.10 being excluded. Should the laboratory report 96.15, the average 96.125 would be taken for settlement, the value 96.30 being excluded. Should the laboratory report 96.20, which is midway between the other polarizations, 96.20 would be taken for settlement. Should the laboratory report 95.80, then the polariza-

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[Reprinted from the Journal of Industrial and Engineering Chemistry
Vol. 9, No. 8, page 810. August, 1917.]

THE CHEMICAL COMPOSITION OF COMMERCIAL GLUCOSE AND ITS DIGESTIBILITY—A REJOINDER

Probably no paper that has appeared in recent numbers of THIS JOURNAL has aroused a greater amount of unfavorable discussion among a certain class of its readers than the one in the November issue of 1916, upon "The Chemical Composition of Commercial Glucose and Its Digestibility," by J. A. Wesener and G. L. Teller.

One of the first difficulties experienced in reading the paper of Wesener and Teller is that of reconciling the experimental part of their paper with the final "Summary and Conclusions." The inconsistencies between these two parts are so pronounced that the reader is forced to suspect that "Summary and Conclusions" has no connection with the rest of the paper, but is only a sort of tag which can be attached or detached at the authors' pleasure. This suspicion has, indeed, considerable outside evidence for substantiation.

The "Summary and Conclusions" of Wesener and Teller's paper was presented, exactly as printed on pages 1019 and 1020 of Vol. 8 of THIS JOURNAL, before a meeting of the Illinois State Food Standards Commission, which was held in Chicago in June, 1916. This meeting, according to the statement by its Chairman, was called by one of the large producers of commercial glucose for the purpose of revising the standards of certain foods "so that there might be a more liberal use of corn syrup, commercial glucose, in them." Wesener and Teller were two of the witnesses to appear at this hearing. For some unknown reason these authors neglected to add to their paper, when printed in THIS JOURNAL, the customary note that it had been previously presented either by summary or title. Whatever the reasons may be for this omission, the fact remains that four months before its publication in THIS JOURNAL, the "Summary and Conclusions" of Wesener and Teller's paper was printed verbatim in the *American Food Journal* (July, 1916, pp. 300 and 301).

It is curious to note that after the publication of Wesener and Teller's paper in THIS JOURNAL, "Summary and Conclusions" was again detached and once more printed in the *American Food Journal* (December, 1916, p. 623), this time with the rather naïve Editorial Statement that it was reprinted through the courtesy of *The Journal of Industrial and Engineering Chemistry*. This attachable and detachable tag, through the courtesy, no doubt, of the *American Food Journal* in which it first appeared, has also been reprinted in various other trade publications.

The main thesis which Wesener and Teller attempt to establish is that when used as a food commercial glucose "pound for pound of dry weight, will furnish at least as much energy

X-S 585
.B8 #21

[Reprinted from the Journal of Industrial and Engineering Chemistry, Vol. 9, No. 7, page 718. July, 1917.]

A CHEMICAL LETTER BY DR. ANDREW URE

Editor of the Journal of Industrial and Engineering Chemistry:

The following letter by Dr. Andrew Ure—the well-known author of Ure's Dictionary—has recently come into my possession and as it was written exactly 100 years ago and contains considerable matter of historical interest, its publication in the July issue of the JOURNAL may not be out of place. The letter, except for a slight tear due to breaking of the wax seal, is in perfect preservation. It bears the address, Dr. Granville, Hotel de Saxe, No. 12 Rue de Colombier, Faubourg St. Germain, Paris, and runs as follows:

GLASGOW, July 5th, 1817

MY DEAR SIR:

I avail myself with great pleasure of the opportunity offered by the visit of my ingenious friend, Dr. N. Hill, to Paris, to assure you of the grateful recollections which I shall ever entertain of your kindness, regretting only that the arthritic affection of my ankles prevented me from profiting so much as I would otherwise have done of your acquaintance with the French *Savans*. My journey homeward was tedious and uncomfortable: but soon after breathing my native Caledonian air my health returned to its former soundness, and the anomalous affections, connected, I believe, with the French wines, entirely disappeared.

Though far distant from you, I have followed with undiminished interest your useful labors and very interesting communications in the Institution Journals. Your tribute to Vauquelin is elegantly expressed, and very justly merited. It has found an echo in every man's heart who has, like me, had the good fortune to meet with this illustrious and benevolent philosopher. I hope soon to have a public opportunity of expressing my sentiments on the same grateful subject.

My winter occupations consist more in teaching pupils the general truths of science than in original investigations. Since the session ended, I have, however, been incessantly occupied in some researches which will make their appearance in monthly succession in our scientific journals—chiefly the *Annals of Philosophy*. In the *Medical and Surgical Journal of London* for this month you will find a paper of mine containing a description and analysis of a morbid intestinal concretion sent to me for examination by a physician in the vicinity of Perth. It differs entirely from any of which I have seen an account, resembling in chemical and physical properties pure ambergris, and containing no earthy phosphates or indeed any other saline matter.

By the analysis of Lagrange ambergris contains benzoic acid. The substance in question yields none to any attempts at extraction which I have been able to make. And on examining with care two different specimens of ambergris, both reputed genuine, I have found the one to contain benzoic acid, but the other, and that the most characteristic, none. The paper itself will shew you that I have bestowed some pains on the subject, though I have by no means completed my investigations, being very much pressed for the account for this month's magazine. Some phenomena led me to fancy that the acid of ambergris was not benzoic but succinic acid; and I accordingly tried to discover a simple and certain criterion between them. Succinate of Ammonia sublimes without decomposition. Benzoate of Ammonia is

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Release February 1, 1917

[Reprinted from the Journal of Industrial and Engineering Chemistry, Vol. 9, No. 2, page 177. February, 1917.]

THE FIRST REPORT UPON THE CHEMICAL INDUSTRIES OF THE UNITED STATES AND THEIR RELATION TO NATIONAL PREPAREDNESS

By C. A. Browne

Received December 20, 1916.

To those who have studied the historical development of Chemical Industries in the United States the recent discussions and papers upon *Industrial Preparedness, Chemical Statistics, Tariff Legislation,* etc., that have appeared in This Journal have a strangely familiar sound. The situation which confronts the manufacturer of chemicals in the United States to-day is not a new one and the present endeavors to make a statistical estimate of the needs of our chemical industries are not the first efforts which have been made in this direction. History has, at times, a strange method of repeating itself. If we of to-day could only transport ourselves to the United States of a century ago we might hear, then, as now, the same fears expressed concerning mushroom prosperity and unpreparedness, we might listen to the same arguments in favor of anti-dumping laws and we might read the same resolutions proposed by Committees who had met in convention to investigate the industrial situation.

The efforts of our great grandsires to solve a condition of affairs so similar to that of the present is not only interesting but instructive. The first business of the ancient Romans, when they met in conclave, was to determine the *consulta patrum;* we can do no better than follow their example.

GENERAL INDUSTRIAL CONVENTION HELD IN 1831

On October 26, 1831, there met in New York City a General Convention of the Friends of Domestic Industry, consisting of about 500 delegates from 13 different States. These delegates, who represented all the leading industries of that time, divided themselves into a number of committees, whose work was to prepare a series of reports upon Iron and Steel, Salt, Sugar and Molasses, Glass, Chemicals and other industries. These reports, which were widely distributed as separate pamphlets, were collected the following year into a single volume which was printed as a 200-page book at Baltimore in September, 1832.

This collection of reports is preceded by an Appeal to the People of the United States and is followed by a Memorial to Congress in which the recommendations of the various Committees are summarized. The volume is carefully edited and contains a vast amount of information, invaluable to historian and statistician. A few extracts from the introductory Appeal

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.88 #23

[Reprinted from the Journal of Industrial and Engineering Chemistry, Vol 10. No. 11, page 916. November, 1918.]

THE POLARISCOPE SITUATION AND THE NEED OF AN INTERNATIONAL SACCHARIMETRIC SCALE

By C. A. Browne

Received August 5, 1918

Among the many claims which are being made upon industry as a result of the present war there are probably none more pressing than the demand for certain kinds of scientific apparatus.

In the sugar industry alone there is a most serious shortage of polariscopes, refractometers, and colorimeters, and with the inability to obtain certain repairs the number of such instruments available for technical control is constantly growing less.

Seventy years ago practically all of the sugar testing apparatus used in the United States came from France, and although most excellent saccharimetric instruments have always been obtainable from that country, nearly all of the polariscopes used in the sugar and food laboratories of the United States at the present time were manufactured in Germany or Austro-Hungary. There are several explanations for this preference for instruments of German manufacture: (1) Since the time of Liebig the technical schools and universities of Germany have been most frequented by American students, the result being a greater familiarity on the part of scientists in this country with instruments of German origin. (2) At the time when many of our industries were established German emigrants were the most available for certain positions and German methods and apparatus were thus naturally introduced. (3) German manufacturers have been much more active than their French competitors in bringing their instruments to the attention of the American public.

With the entrance of the United States into the present war the importation of scientific apparatus from Germany and Austria came to an end. Those who needed polariscopes were thus obliged, as 70 years ago, to turn to France, the birthplace and original home of this instrument. The optical establishments of France were so taxed, however, with the manufacture of periscopes, field glasses, gun sights, etc., that no time could be spared for manufacturing other apparatus, although the instrument-makers of France

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Influence of Conditions Upon the Polarizing Constants of Sugar Cane Products.*

(*By Dr. C. A. Browne.*)

The influence of conditions upon the single and double polarization of sugar cane products is one of the most instructive phenomena which can engage the attention of the chemist. A knowledge of the effect of these conditions will frequently give the analyst a deeper insight into the nature of his products than can be obtained in any other way. Climatic factors, maturity of cane, methods of manufacture, age of product and other causes all exercise a distinctive influence upon the polarizing constants.

The two constituents of the sugar cane which exercise the greatest influence upon the polarization of cane products, in addition to sucrose, are the reducing sugars, dextrose and levulose. In fact these sugars exist in much greater quantity than sucrose in very immature canes at which stage the dextrose and levulose occur in approximately equal amounts, or in the proportion represented by invert sugar. At later stages of growth the dextrose of the cane slightly exceeds the levulose, but the difference is usually so small that the reducing sugars of the cane can be estimated as invert sugar without very large error. For equal weights of sugar the reducing power of levulose upon Fehling's solution is to that of dextrose as 92 to 100, so that there can be a considerable fluctuation in the percentage of either sugar before the average reducing power of 96 is sensibly disturbed.

In polarizing power, however, the rotation at 20 degrees C. of levulose is to that of dextrose as -92.5 is to $+52.5$ so that a very small fluctuation in the percentage of either will change considerably the average rotation of -20.0 for pure invert sugar. Accepting $+66.5$ as the specific rotation of sucrose and -20.0 as that of invert sugar, for a 10 per cent solution at 20 degrees C., the ratio $-\frac{20}{66.5}$, or 0.3, will be the depressing influence of 1 part of invert sugar upon the polarizing power of sucrose. In other words a product containing 80 per cent sucrose and 10 per cent invert sugar will polarize 77 instead of 80.

The value -0.3 is the constant for pure invert sugar in a neutral solution at 20 degrees C. In the Herzfeld method of double polarization, where 5cc of concentrated HCl per 100 cc of solution is used for the inversion, the polarizing power of invert sugar is increased from -20.0 to -20.6 which would give a ratio of $\frac{20.6}{66.5}$, or -0.31. It may be stated as a general rule that if the percentages of dextrose and levulose in cane products are approximately equal, the Clerget value for sucrose (S) will exceed the direct polarization (P) by about one-third the percentage of invert sugar (I), when the polarizations are made at 20 degrees C.

INFLUENCE OF CLIMATE ON POLARIZING CONSTANTS.

In tropical countries where the average laboratory temperature is considerably above 20 degrees C. the polarizing power of sucrose and levulose are considerably reduced with the result that the factor $\frac{S-P}{I}$ is changed. The character of this change will depend upon the nature of the product; with sugars, massecuites, etc., polarizing over 85 the ratio $\frac{S-P}{I}$ will generally increase with elevation of temperature, whereas with molasses and low purity products polarizing below 80 the ratio under similar conditions will usually diminish.

This is shown in Table I which gives the polarization constants at 20 degrees C. of four sugar cane products:

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* *Paper read before the meeting of the American Chemical Society, Cleveland, Sept.* 11, 1918.

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Prevención de las Pérdidas Debidas al Deterioro de los Azúcares Brutos.

(Por el Dr. C. A. BROWNE.)

CON la terminación de la presente zafra en los Trópicos y al quedar libres más de un millón de toneladas de azúcar hasta ahora almacenadas en los Ingenios, habrá que satisfacer un tributo mayor por pérdidas debidas al deterioro que el que nunca se haya pagado en la historia de la industria azucarera.

En años anteriores cuando la cosecha de azúcar era trasportada con mayor rapidez, la exacción por concepto de deterioro era satifecha mayormente por el comprador. El refinador, sin embargo, con ese conocimiento de las condiciones que gobiernan la calidad de aguante del azúcar, refinaba aquella parte de sus existencias que estaban más expuestas a deteriorarse y reservaba para almacenarlas aquellas otras que ofrecían mayores probabilidades de conservación. Favorecido por el conocimiento de pasadas experiencias, por buenas facilidades de almacenamiento y por la acción dilatoria de un clima fresco sobre el proceso de deterioro, le era dable reducir sus pérdidas por almacenamiento a una cifra insignificante en la mayoría de los casos.

Pero las condiciones son muy otras con el azúcar que este año ha estado almacenado en los Trópicos. Prácticamente no se ha hecho selección alguna entre los azúcares que poseen buenas y malas cualidades de conservación. Este hecho, cuando se le toma en cuenta con el periodo extraordinariamente largo de almacenamiento y la influencia aceleradora que los climas tropicales ejercen sobre el proceso de deterioro, explicará el por qué las pérdidas de la zafra azucarera de 1918, desde el momento de su fabricación hasta que llega al consumidor, han de exceder a todos los records anteriores.

Aun cuando hay la tendencia general en Cuba y Puerto Rico de fabricar azúcares brutos de mejores cualidades de conservación, el número de Ingenios que fabrican un producto uniformemente estable constituye todavía una insignificante minoría. Analisis de azúcares procedentes de Ingenios cubanos por un número de años atrás demuestran que el 60 por ciento de los Ingenios mejoraron la calidad de conservación de sus azúcares brutos en 1916 en comparación con 1914. De estos mismos Ingenios un 60 por ciento acusó otra vez una mejoría en 1917 en comparación con 1916. Una mejoría general en la calidad de conservación se hace patente y sin embargo de 121 marcas de azúcar centrífugo cubano analizadas en 1917 como una cuarta parte solamente podían considerarse extrictamente como de buena calidad de conservación. La clasificación de estas marcas conforme a su calidad de conservación se consigna en la Tabla I.

Tabla I.

Calidad de conservación.	Promedio de los análisis Por ciento del total	Polarización.	Humedad.
Buena	23	95.12	1.17%
Mediana	21	95.23	1.30
Mala	48	95.52	1.40
Muy Mala...	8	95.42	1.69

El promedio de todas las 121 marcas fué de 95.36 de polarización y de 1.34 por ciento de humedad, siendo esta última cifra como un 0.2 por ciento demasiado alta para una conservación segura. Los resultados precedentes están basados en analisis hechos en New York de azucares que probablemente habían ya perdido alguna humedad durante el transporte y almacenamiento y en la operación de extraer las muestras y mezclarlas. El promedio de los azúcares de cen-

On the Manufacture of Polariscopes in the United States.

X-S 585
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X-S 585 .B8 #26

(By Dr. C. A. Browne.)

With reference to the recent article by the writer upon the Polariscope situation in THE LOUISIANA PLANTER for December 7th, it is a satisfaction to announce that steps have already been taken by the Bausch & Lomb Optical Company to manufacture a commercial saccharimeter that will conform as nearly as possible to the requirements of those who employ this instrument under the varying conditions of a temperate and tropical climate. In order that manufacturers might have a clear idea of the points which American chemists consider desirable in a saccharimeter an outline of tentative specifications was prepared and sent to sugar chemists in the United States, Hawaii and Cuba, with the request that these specifications be amended or supplemented in such ways as conform with the best results of their experience. From the replies received from this inquiry a final outline of specifications will be prepared for publication. It seems reasonable to suppose that after striking a balance between the general opinions of those who actually use polariscopes, a more convenient and generally useful form of saccharimeter may be evolved than has yet appeared upon the market.

Heretofore sugar chemists have been obliged to accept the forms of apparatus listed in catalogues, although the most casual inspection showed that manufacturers in some features of their instruments did not have a clear understanding of the needs and wishes of chemists. Only recently a shipment of saccharimeters was received in this country from a foreign manufacturer. These instruments in convenience and accuracy violated practically every item of construction and, as a consequence, the bad name specifications for saccharimeters will inform spread far and wide. The importer of these instruments has the entire lot upon his hands and naturally has reason to deplore the folly of a manufacturer who would construct instruments according to his own personal ideas and not according to the wishes of the trade. The publication by American sugar chemists of specifications for saccharimeters will inform manufacturers of their preferences and prevent the recurrence of such happenings as the one just noted.

It has seemed to many American sugar chemists that in beginning the manufacture of saccharimeters in the United States an effort should be made to get away from the illogical inaccurate German sugar scale and to start anew upon the more simple, convenient, international scale which was proposed by Sidersky and Pellet in 1898. The arguments for the international normal sugar weight of 20 g. were given in my paper in the PLANTER for December 7th. The following points of advantage are again enumerated. (1) The 20 g. scale being a compromise between the French 16.29 g. scale and the German 26 g. scale, is free from all national bias. (2) The results obtained with the 20 g. normal weight are easily converted into percentages by multiplying by 5, while percentages are converted into grams per 100 cc. by multiplying by 0.2. The results obtained by the French or German normal weights are not thus easily transformed. (3) Aliquot portions of 50, 25, 20, 10 and 5 cc. of the 100 cc. international normal sugar solution represent even gram quantities (10, 5, 4, 2 and 1 g., respectively), which is not the case with the French or German standards. (4) In case of non-uniform or irregular samples it is easy to make up multiples of the international normal weight such as 50 g. to 250 cc. or 100 g. to 500 cc. Such multiples with the French or German normal weight are difficult to manage. (5) The specific rotation of sucrose at a concentration of 20 g. in 100 cc. (18.61 per cent) is about the maximum, while it is perceptibly lower at concentrations above or below this amount. (6) The 20 g. normal weight, its fractions and multiples are always available as one piece units in the analytical set. The French and German normal weights, their fractions and multiples are not always available as one-piece units and to make up the quantity from an analytical set of weights is inconvenient as well as open to error.

A number of objections to the proposed change have been received. (1) By diminishing the normal weight from 26 g. to 20 g. the scale will be shortened and the sensibility of reading diminished to 20/26, or to about 4/5, of its original amount. This objection, which applies only to the re-scaling of old instruments, is easily overcome by increasing the magnification of the reading microscope. For new instruments the quartz wedge can obviously be constructed so as to give any length of scale desired. (2) By diminishing the normal weight from 26 g. to 20 g. the accuracy of the sample is diminished to 20/26 of its original value. In other words if non-uniformity of sample caused duplicate tests to vary 0.10 with 26 g. of product it would cause duplicate tests to vary 0.13 with 20 g. of product. In reply to this objection it may be said that the stock charge for most analytical operations is considerably less than 20 g. The French normal weight is only 16.29 g. and no objection has ever been brought against this standard on the ground of inadequacy of sample in case of normal products. In the case of badly mixed non-uniform products there are instances where even a sample of 26 g. of sugar is adequate and it is right here that the international normal weight shows its superiority. With samples which are very abnormal it is a simple matter to dissolve 50 g. of product in 250 cc. or 100 g. of pro-

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.B8 #27

The Consideration of Some Objections to the Proposed 20-Gram International Saccharimetric Scale.

(*By C. A. Browne and Noel Deerr.*)

A recent canvass to determine the opinion of sugar chemists concerning the adoption of certain reforms in the manufacture of polariscopes, undertaken by independently acting committees and individuals, showed a very general belief that the present was a fitting time to discontinue the inconvenient French and German saccharimetric scales and to adopt instead the International Scale, which is based upon a decimal normal sugar weight of 20 grams.

As an indication of the sentiment upon this question the Hawaiian Sugar Chemists' Association, with a membership of about 100, voted almost unanimously for the proposed change. The Louisiana Chemists,* at a recent meeting, attended by about 40 of their number, passed a similar vote. The votes of these associations, together with opinions expressed by individual chemists in various parts of the United States, Canada, Cuba, the West Indies and Great Britain, indicate a preponderance of opinion in favor of the 20-gram scale of over ten to one.

In a recent criticism of the 20-gram scale by Dr. Frederick Bates, in THE LOUISIANA PLANTER of April 5, the statement was made that under the above procedure an unbiased expression of opinion could hardly be obtained; that chemists "have been presented with a sort of symposium as it were in favor of the 20-gram weight," and that, if they were inclined to consider the objections to such a change they would practically be compelled to create their own arguments. This charge is hardly justified for the symposium referred to contains opinions which are adverse as well as favorable. It is moreover a reflection upon the intelligence of chemists to say that they would unhesitatingly accede to a proposition without carefully considering all the pros and cons.

The canvass of opinion upon the normal weight question brought out a number of objections against making any change in standard and as some of these objections were not advanced by Dr. Bates, a general review of the leading arguments against the proposed change in standard is herewith presented.

* *Louisiana Planter, Jan.* 25, 1919, p. 58.

In order to prevent misunderstanding it will be necessary first of all to straighten out a tangle of nomenclature in to which some of our friends upon the other side have become involved. An objection has been raised against calling the 26-gram scale German, or Ventzke, and the word International has been used as a substitute for these terms. The word "International" is used in this sense, for example, in Bureau of Standards Circular No. 44, although this term had for many years previously been applied to the 20 gm. scale, not only in such standard books as Sidersky's "Saccharimetrie et Polarimetrie" (Paris, 1908 edition, pp. 100-103), but in the catalogs of instrument makers. The terms German and Ventzke did not go out of use with the adoption of the 26-gram normal weight, as reference to the literature will show. In an official statement received before the war from the Physikalisch-Technische Reichsanstalt of Charlottenburg, the highest authority upon German standards of weight and measure, the term Ventzke is still applied to the 26-gram scale. We cannot see, therefore, why the accustomed designation of this scale should be considered as inaccurate or unfair.

The misuse of terms, which has resulted from calling the German, or Ventzke, scale "International" unfortunately has crept into the trade, for some 26 gram normal weight saccharimeters are now sold that bear the stamp "International Sugar Scale." Under present circumstances one can understand the desire of manufacturers to find a substitute for the distasteful word "German," but this is no excuse for adopting a term that has been attached for many years to another scale.

The reasons lately proposed in favor of the 20 gram scale were not recently prepared but are practically the same arguments as presented by Sidersky, Pellet, and Dupont before various sessions of the International Congress of Applied Chemistry(1). The fact that Dupont's

(1) *Reports of the International Congress of Applied Chemistry IV.* (1900), pp. 131-132; *V.*, (1903), pp. 129-135; *VI.* (1906), pp. 563-569.

X-S 585
·B8 #28

The Loss of Moisture from Sugar Samples Under Different Methods of Preservation.*

(*By C. A. Browne and G. H. Hardin.*)

The loss of moisture from sugar samples between the times of sampling and analysis is one of the most important causes of difference in tests. It has been the experience of the New York Sugar Trade Laboratory that the most frequent number of such differences is due to this cause although the divergences which result therefrom are not usually so great as those produced by deterioration.

The New York Sugar Trade Laboratory receives two samples of each sugar, one of which is immediately tested and the other set aside as a reserve. As all raw sugars dry out during storage, the reserve samples show, after a few days, a higher test than the original samples except in case of deterioration. If the request for a retest be deferred for several weeks, as often happens, the difference in polarization between original and reserve samples may amount to several tenths of a percent. As the samples of sugar received by the Laboratory are sent in various ways, experiments were made to determine the loss in weight which sugars undergo with different methods of preservation.

The official container of the New York Sugar Trade is a tin can with soldered water-tight joints, 4 inches deep, 3 inches in diameter and provided with a closely fitting cover 3/4-inch deep. The can holds about 400 gms. of sugar. The first experiment was carried out upon ten containers of this kind filled with raw sugar of different marks and with covers in place but not sealed. The experiment was continued for 34 days, the samples being weighed at first every day and then on alternate days. The following summary of the results is given:

The average daily loss in moisture during the 34 days of the experiment was 0.0406 g. per can, or $.0103 per cent of the weight of sugar and the average daily increase in polarization was 0.0115.

The smallest average daily loss in moisture for the ten samples was 0.0053 per cent during the first day, which was rainy and of high humidity. The greatest average daily loss in moisture was 0.0149 per cent during the second day, which was cool and dry. The second greatest average daily loss was 0.0144 per cent on the sixteenth day which was also dry. The daily loss of moisture was fairly constant although as a rule it diminished slightly, as time progressed, there being a considerable fluctuation according to atmospheric humidity. The greatest daily loss for any one sample was 0.0235 per cent for sample 813 on the sixteenth day.

It is customary with some who prepare samples to force the sugar tightly into the can and to seal the joint between can and cover with wax. The second experiment was carried out upon ten containers filled in this way with different marks of sugar. The time of the experiment was 36 days.

The average daily loss during the 36 days of the experiment was 0.0391 g. per can or 0.0088 per cent of the weight of sugar, which is only 0.0015 per cent less than in the previous experiment where the cans were unsealed.

* *Paper read before the Division of Agricultural and Food Chemistry, at the Buffalo Meeting of the American Chemical Society, April 7-11, 1919.*

TABLE 1.

(*Change in Moisture and Polarization of Sugar Samples in Unsealed Tin Cans.*)

Sample Number.	Wt. Sugar Feb. 16 gs.	Wt. Sugar Mar. 21 gs.	Loss gs.	Per cent Loss %	Residual Moisture Mar. 21 %	Polarization Original Can Feb. 16	Polarization Reserve Can Mar. 21
800	400.97	399.09	1.88	0.47	0.98	95.15	95.70
801	370.51	368.68	1.83	0.49	0.84	95.55	96.10
802	387.05	386.20	0.85	0.22	1.11	95.65	95.90
803	408.93	407.75	1.18	0.28	0.95	95.85	96.15
804	417.85	417.05	0.80	0.19	1.04	95.90	96.10
805	386.67	385.60	1.07	0.28	0.58	96.05	96.45
810	400.80	399.32	1.48	0.37	0.55	96.90	97.25
811	387.53	385.85	1.68	0.43	0.50	96.80	97.20
812	387.36	386.52	0.84	0.21	0.78	96.50	96.60
813	419.58	417.41	2.17	0.52	1.01	95.90	96.70
Average	396.73	395.35	1.38	0.35	0.83	96.03	96.42

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.B8 #29

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The Testing of Saccharimeters by Means of the Telescopic Control Tube

By C. A. Browne

X-S 585
·B8 #30

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The Testing of Saccharimeters by Means of the Telescopic Control Tube

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By C. A. Browne

Observations on the Use of Different Types of Saccharimeters

X-S 585
-B8 #31

(By Dr. C. A. Browne.)*

A leading expert in the manufacture of chemical apparatus in this country recently made the statement that the high-water mark period for laboratory instruments, when the purchaser could get the highest standard of excellence for the least money, was reached in the years immediately preceding the late war. The user of apparatus, in his present state of desperation, when the lower possibilities of achievement compel him to accept either inferior instruments or none, looks back upon this pre-war period as a sort of golden age. No one has probably felt the effects of this decline in excellence more acutely than the sugar chemist. During the recent saccharine famine it was amazing to note the number of antiquated polariscopes that suddenly emerged from their dusty hiding places. Old instruments of the Duboscq, Schelhler and Mitscherlich types were lacquered up and sold at a handsoma figure. An accuracy within three-tenths was cheerfully accepted where an error of one-tenth would previously have meant indignant rejection. Several purchasers of these old instruments brought their finds to the writer's laboratory for examination and some very interesting as well as amusing facts, were brought to light as a result of this inspection. We must pass over all this, however, and confine our discussion to the observations made upon five different types of saccharimeters with which manufacturers in America, England, France, Germany and Bohemia are attempting to relieve the present shortage.

The first pinch of the war in the experience of American Sugar Chemists was the difficulty in replacing some of the most ordinary polariscope accessories such as tubes and tube cover glasses. The case of the cover glass, the simplest piece of apparatus which sugar chemists employ, is instructive as it offers an excellent illustration of the difficulties which suddenly confronted us. The first substitutes offered by dealers in place of the regulation covers were discs of ordinary window glass, which sold for the magnificent sum of 25 cents apiece. They contained numerous flaws, their surfaces were not planed parallel and their deep green color impaired the intensity of the light in the field. But for a time, fortunately a brief one, these were the only covers available and chemists had to use them or do without. With the manufacture of optical glass in this country, instrument makers were able to take a long step in advance; cover-glasses were so improved that as regards optical properties and plane parallelism they were practically perfect, but, as regards durability, they were still inferior to the old pre-war standard. They split and cleaved easily around the edge; they cost twice as much as the old covers, but their life was only about one-quarter as long. After some experimenting it was found that by more careful annealing and by beveling the sharp edges of the glass slightly, these defects of fracture could be removed so that we have finally domestic cover-glasses equal to those which were imported before the war.

This illustration of the cover glass is typical and it applies to every single feature of the saccharimeters. The perfection of any instrument is a process of slow growth and evolution, and manufacturers who enter a new field must acquire and accumulate experience.

Coming now to the saccharimeter itself let us consider first the question of general construction of which there are two distinct types—the open construction or French type and the closed construction or German type of instrument. Each of these types has certain distinct advantages as well as certain distinct disadvantages. The open construction has the advantage of accessibility of parts and the French saccharimeters can usually be very easily dissected in some cases without the necessity of removing a screw, the various parts slipping or turning into position. Easy accessibility is desirable in tropical countries where the prisms require frequent attention owing to the attacks of fungi which unless quickly removed will soon ruin the instrument. It is also desirable in remote localities in order that damaged parts may be easily detached and sent away for repairs without the necessity of shipping the whole instrument. Objections to the open construction are that, it does not exclude dirt, that contamination of the wedges, etc., with drops of spilled solution is more easy, that it induces frequent tampering and that it prevents securing the rigidity necessary for preserving the accurate permanent alignment of the optical parts. These objections to the open construction are all valid, but the advocates of the closed construction have gone too far in the opposite direction. I would criticize especially a familiar model of the closed type in which the parts are fastened in with such a multitude of fittings and screws that it is a day's work to dissect the instrument and re-assemble the parts. The most common necessary operation of removing the splash glass requires the use of a screw-driver and, as one chemist has expressed it, "of much profanity." On one recent saccharimeter of the closed type the screw for adjusting the scale is closed within the protection case, which covers the wedges, so that the rim of the case must be unscrewed and removed before the regulating pin can be turned. Such a contrivance may prevent tampering with the scale, a common fault of young chemists, but will defeat its own purpose in the end for users of the instrument will soon remove the protection case once for all rather than waste thirty precious minutes every few days to make an adjustment which through a covered hole in the case could be made in thirty seconds. There is a happy medium between the closed and open construction towards which manufacturers should aim. The recent models of French saccharimeters show a tendency towards such a compromise and the saccharimeter of the

* *Read before the Sugar Section at the Fifty-ninth Meeting of the American Chemical Society, St. Louis, April 15, 1920, and published by courtesy of the American Chemical Society.*

(1) *Das optische Drehungsvermögen, 2nd Edit.*, pg. 339 (1898).

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.B8 #82

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Moisture Absorptive Power of Different Sugars and Carbohydrates under Varying Conditions of Atmospheric Humidity

By C. A. Browne

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B8 #33

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Vol. 14, No. 11, page 1066, November, 1922.]

Early Chemical Industry in America—A Few Comparisons of Past and Present Conditions

By C. A. Browne

X-S 585
'B8 #34

[Reprinted from Industrial and Engineering Chemistry,
Vol. 16, No. 1, page 90. January, 1924]

Gulian C. Verplanck's Account of Alchemy in Old New York[1]

By C. A. Browne

New York Sugar Trade Laboratory, New York, N. Y.

WITHIN the past few years a sufficient amount of documentary and literary material has been gathered in different quarters to prepare a volume of considerable size upon the history of alchemy in America. The idea that alchemists ever existed in the Western Hemisphere was confined for seventy years to romance writers such as Hawthorne, who in his story, "The Great Carbuncle," painted an imaginative picture of the alchemist, Dr. Cacophodel, which in its various details is characteristic of the literary type: "He wore a high crowned hat shaped somewhat like a crucible. He was from beyond the sea, had wilted and dried himself into a mummy by continually stooping over furnaces and inhaling unwholesome fumes during his researches in chemistry and alchemy."

With the publication of old papers belonging to the Winthrop and other New England families by the Massachusetts Historical Society, it began to appear that there actually were alchemists in colonial America. James Russell Lowell, in his essay on "New England Two Centuries Ago," published in 1865, was among the first to call attention to this fact. Later with the publication of other old documents such as the Diary of President Ezra Stiles, of Yale University, it was seen that the practice of alchemy prevailed, not only in New England, but existed in New York, Pennsylvania, and other colonies to the South. George L. Kittredge, in his life of "Doctor Robert Child the Remonstrant" (Vol. XXI. The Colonial Society of America, 1919), devotes twenty pages to a very excellent summary of early alchemy in New England. It is hoped that other investigators may do as much for the middle and southern Atlantic colonies.

Concerning early New York alchemists, there is a tradition preserved in the Diary of President Stiles of an old German, Dr. Benson, who in the early part of the eighteenth century was accustomed to leave his home in New York and, after going up to a cave in the mountains about West Point with his crucibles and other apparatus, would return with plenty of silver. He was a very learned man, dressed carelessly, and loved to play tricks upon boys by asking them to pick up globules of quick-

[1] Presented before the Section of History of Chemistry at the 66th Meeting of the American Chemical Society, Milwaukee, Wis., September 10 to 14, 1923.

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.B8 #35

Recent Contributions to the Chemistry of the Cotton Plant and Its Products

By C. A. Browne

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.B8 #36

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to my attention is the paper by Bessie Goldstein in the Torrey *Bulletin*, in which she shows that the reports of the occurrence of binucleated cells by Hutchinson and by Beer and Arber were due to the observation of cells with cell-plates in polar view.

A limited number of high-class criticisms written for the sole purpose of criticizing are undoubtedly beneficial. This applies especially to books and papers accepted for publication by non-scientific editors. But I for one do not feel the need of further burdening our already over-taxed publication facilities with fault and flaw finding Philippics which add nothing to the sum total of human knowledge. *Botanical Abstracts* supplies us with satisfactory reviews of all papers. Is it not well that *ex cathedra* critical effusions are giving place to the reinvestigation of critical problems?

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EVOLUTION AND THE BIBLE

UNDER the above caption, Dr. Ira D. Cardiff, in SCIENCE of July 31, very properly points out that many of those who are coming forward to the defense of evolution are not scientists of any standing. Probably some of those defending the Biblical account of creation are not scholars of any standing. Debates will undoubtedly frequently be held by people of little or no training in either of the fields that they are discussing. Votes taken by audiences listening to such debates are nothing more than expressions of opinion on the efficiency of the individual debaters, but that is true of debates on practically all subjects, and there is in it no serious danger either for science or religion.

It is quite as foolish for a specialist in religion to attempt to criticize and to analyze scientific subjects with which he is not familiar as it is for a scientist to attempt to criticize and analyze religion or the Bible unless he is thoroughly familiar with the subject.

Many scientific men of good standing in their specialties are quite ignorant of closely related scientific fields, and grossly ignorant of the history and philosophy of religion. There are many others, however, who while they have become great specialists have also given as careful study to other unrelated fields. I happen to know quite a number of the scientists of high station referred to by Cardiff as having done harm to science by their statement that there is no conflict between science and religion, meaning presumably the Christian religion in its broadest sense. I think it may be fairly said that their statement represents the conviction of a very large number if not the majority of scientific men with whom in the past thirty years I have had occasion to discuss this subject. There can be no conflict between truths in the two fields. No scientist will refuse to recognize truth wherever he finds it. I am glad the "scientists of high station" had the "moral courage" to make the statement they did.

Mr. Cardiff is doing the real harm to science by taking an unscientific attitude toward religion.

ALBERT F. WOODS

UNIVERSITY OF MARYLAND

I can not help thinking that Dr. Ira D. Cardiff, in his letter (SCIENCE, July 31, p. 111) on "Evolution and the Bible," is really quite off on the wrong track.

The first chapter of Genesis is not in the least "primitive Jewish folk lore"—though most of the second chapter pretty certainly is. But that "Elohist" first chapter, in its present form, is probably nearly as late as Aristotle's day, and, on the whole, fair Mediterranean science of its time. The weakness of the fundamentalist argument is that it reads into this by no means absurd account of creation various ideas that are not there at all. The way, then, to meet his demand that we shall "take the Bible literally" is to take him at his word and do precisely that. Do this—with a good dictionary—and it immediately appears, that although, naturally, Genesis I does not support "Darwinism," neither does it any more support the "Linnaeanism" which the anti-evolutionists read into it.

I do not happen to know how skillfully this Mr. Cantrell may have handled his case before an audience; but I do think he is pursuing a sound strategy. After all, the Bible does not support fundamentalism. Therefore, the way to beat the fundamentalist is to get him to read the Bible—which he rarely does, being too busy hunting up proof-texts.

E. T. BREWSTER

ANDOVER, MASS.

SCIENTIFIC BOOKS

History of the Beet (Beta) as a cultural Plant (Geschichte der Rübe (Beta) als Kulturpflanze) from the oldest times until the publication of Achard's principal work (1809). An anniversary essay, in honor of the 75th year of the foundation of the "Verein der Deutschen Zuckerindustrie." By PROFESSOR DR. EDMUND O. VON LIPPMANN, Hon. Dr. Eng., Technical High School of Dresden and Director of the Halle Sugar Refinery in Halle, Germany. One illustration, 184 pages, 16 × 23½ cm. price bound 12 gold marks. Julius Springer, Berlin, 1925.

THE present volume is the third quarti-centennial essay which has been issued by the "German Indus-

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fused by the use of the microfarad with its numerical factor of 10^6. As a matter of fact, the kilogram itself is too large for convenience in most scientific work. Both Dr. Campbell's proposal and that of the writer lose what was considered an advantage of the C.G.S. system, that the density of water is approximately equal to unity; so there is no choice on this point. A great convenience of the writer's proposal is that energy, power, force, mass and other quantities directly derived from them all have units larger than the C.G.S. units by the same factor 10^7. This would result in great convenience in referring to existing tables of physical data, since the reader would only have to decide whether to introduce this single factor; whereas with Dr. Campbell's proposal factors of 10^{-3}, 10^{-4}, 10^{-5} and 10^{-7} are given in his Table I, and other factors would enter with subordinate quantities, such as pressure and density. It is believed by the writer that these conveniences far outweigh the inconvenience of a large unit of mass.

USE OF THE TRUE OHM

Dr. Campbell's proposal to use the international ohm, coupled with the use of the mechanical watt, requires many of the electrical quantities to be expressed in units which have never heretofore been employed. While it is true that these units differ to a very slight degree from either the international units or the true (practical) units, nevertheless it is felt that the results would be decidedly confusing. The writer's proposal is to use the true practical electrical units throughout, which is consistent with the mechanical watt. These units are all related to the C.G.S. electromagnetic units by factors which are exactly powers of 10; so that conversion from the C.G.S. electromagnetic system would be greatly facilitated. For engineering purposes, of course, the differences between the international electrical units, the practical electrical units and the electrical units proposed by Dr. Campbell are insignificant.

The units proposed by the writer seem to require a minimum of change from existing practice and yet to have the broad advantages of definitive units as expressed by Dr. Campbell. With the exceptions of the units for force and mass and their derivatives, these units are all in wide use at present. The complete system has for several years been employed by the writer in his electrical engineering classes[2] and for his own computation in fields where electrical and mechanical quantities continually occur together in a variety of ways.

In the writer's opinion, the most important consideration in the introduction of a system of definitive units, assuming the units to be consistent and of *reasonable* magnitudes, lies in *the convenience of the transition from present practice.* The system proposed permits of a gradual adoption of the few new units, as fast as their advantageous features become appreciated; whereas Dr. Campbell's proposed system requires more radical changes.

L. A. HAZELTINE

STEVENS INSTITUTE OF TECHNOLOGY

[2] See L. A. Hazeltine, "Electrical Engineering," The Macmillan Company (1924).

TIME MEASUREMENTS

THE fact that a watch keeps correct time over a period of twenty-four hours is not a sufficient indication of its accuracy in the measurement of short time intervals where the second hand is used. A slight misplacement of the watch dial may cause the pivot of the second hand to be located "off center," thus causing an error of as much as two seconds in measuring an interval of twenty, or twenty-five seconds. Readings on one half of the dial will be too short and those on the other half correspondingly too long.

A similar source of error may be looked for in any dial-reading instrument where particular care has not been taken in fixing the dial position.

RALPH G. DEMAREE

PASADENA, CALIFORNIA

ARTIFICIAL CULTIVATION OF FREE-LIVING NEMATODES

IN SCIENCE, N. S. Vol. 60, No. 1548 (Aug. 29, 1924), pp. 203–204, under the above title, Asa C. Chandler describes a method dependent on the standard culture-methods of bacteriology. So far as developed, this method does not apparently differ from that described by me in the *Trans. Amer. Mic. Soc.*, Vol. 24, pp. 89–102, 1 pl., 1903.

HAVEN METCALF

BUREAU OF PLANT INDUSTRY

SCIENTIFIC BOOKS

The Story of Early Chemistry. By JOHN MAXSON STILLMAN, late professor emeritus of chemistry, Stanford University, xiii + 566 pages, $5\frac{1}{2} \times 8\frac{1}{2}$ inches. D. Appleton and Co., New York, 1924, Price $4.00.

THE amiable author of this scholarly volume (whose recent death was lamented by a host of friends) has long been known as a contributor to the history of medieval chemistry—more particularly of that transitional Paracelsian epoch which was contemporary with various other great movements of exploration, renaissance and reform. It was only natural, therefore,

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Chronological Table

Of Some Leading Events in the History of Industrial Chemistry in America from Earliest Colonial Settlements until the Outbreak of the World War

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By C. A. Browne

Publication Office Easton, Pa. Editorial Office Mills Bldg. Washington D.C. Advertising Dept. 19 & 24th Str. New York

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Vol. 3, No. 7. July, 1926.]

Historical Notes upon the Domestic Potash Industry in Early Colonial and Later Times

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C. A. Browne, Chief, Bureau of Chemistry, Washington, D. C.

Book Review by C. A. Browne.
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stinging occurs, and the invariable similarity of the attacks.

CHAS. E. VON GELDERN, M.D.

SACRAMENTO, CALIF.

SCIENTIFIC BOOKS

Three Centuries of Chemistry, Phases in the Growth of a Science. By IRVINE MASSON, D.Sc., F.I.C., professor of chemistry and head of the department of pure science, The University of Durham. The Macmillan Company, New York, 1926, 191 pages, 1 plate.

OF the recent histories of chemistry which have come to the reviewer's notice, the present work is one of the most stimulating and inspiring. The volume is not a complete history, even for the three centuries which it is supposed to cover, the author having "chosen to portray the genesis and evolution of ideas rather than to rehearse every discovery that gains a place in our chemical text-books." Very little information, for example, is given concerning the rise and development of organic chemistry, these phases of the subject being regarded by the author as of too specialized a character for the non-technical reader. Professor Masson's book, therefore, should not be read as a mine of information, but rather for its suggestiveness and the inspiration which it arouses to pursue further the history of a great department of science.

In Part I, upon "The Rise of Scientific Thought," the author after a brief introduction discusses the work of Sir Francis Bacon and its influence in establishing the Philosophical or Invisible College of London about the beginning of 1645. From this club of scientists there afterwards emerged the Royal Society which Professor Masson regards as the *fons et origo* of a considerable part of subsequent scientific developments. He mentions in this connection the stimulating influence of Boyle and others of the Royal Society upon their fellow member, John Winthrop, Jr., the founder of chemistry in the English Colonies of North America. The letters written to the Royal Society by Winthrop, Leonard Hoar, William Avery and others are of particular interest to American readers, for they show that the efforts of the society "to season the youth of New England with its experimental philosophy" had begun to bear fruit.

In Part II upon "The Genesis of Modern Chemistry" the influence of Boyle "the father of chemistry" is traced. This section of the book is most delightful reading, for fine scholarship is intermingled with warm human interests. It is the most accurate and appreciative evaluation of the work of Boyle that has yet been published and deserves to be read again and again.

In Part III upon "The Search for the Elements" five interesting chapters are devoted to the work of Mayow, Hales, Hooke and other English chemists upon combustion, to the growth of the phlogiston hypothesis under Stahl, to the development of the use of the balance under Black, to the investigation of gases by Cavendish and Priestley, and to the final overthrow of the conceptions of the four elements and of phlogiston by Lavoisier. In this section Professor Masson gives well-balanced accounts of the work of these chemists with brief references to their influences and personalities. In commenting upon the inheritance of scientific knowledge, on page 96, he traces Mayow's experiment of burning a candle in a jar inverted over water back to Sir Francis Bacon. He might have followed this path of transmission to a much earlier date, for the experiment is recorded in a Latin translation (*De Ingeniis Spiritualibus*) of the "Pneumatica" of Philo of Byzantium who lived in the second century B. C.

In Part IV upon "The Search for the Structural Units," the final section of his book, Professor Masson traces the development of the ideas of the molecule, atom and ion. This is the least satisfactory part of an otherwise most successful volume, for the treatment is one which appeals neither to the chemist nor to the non-technical reader. The effort to crowd the chemical developments of the past 125 years into a small compass of forty pages is an impossible task under almost any plan of curtailment. Part IV of "Three Centuries of Chemistry" is in consequence a fragment with little of the humanistic atmosphere which gives so much of quality and charm to the earlier pages. The postscript upon Professional Chemistry, which Professor Masson has added to his book, is an essay that will appeal more to teachers of chemistry than to the general reader.

"Three Centuries of Chemistry" leaves the reader with the unsatisfied feeling of a person who has had his appetite whetted for more. One wishes that Professor Masson might have included many more of the personal sketches which he has drawn so vividly in the case of Bacon, Black, Cavendish, Hartlib, Hooke, Mayow, Petty, Priestley, Wallis, Wilkins and Wren. These pen pictures are almost epigrammatic in brevity, yet they convey clean-cut impressions, so that the reader is in no doubt as to the character and personality of the men described. Hooke, for example, is portrayed as "a hollow-cheeked, sallow, wry-bodied little man; a 'fretful porpentine,' far too ready to stick a quill into any one whom he suspected of impinging on his own discoveries; very jealous for his own credit, in that uncomfortably assertive way sometimes seen in an unprepossessing person with a good brain." The reader not only sees the man but actually knows him.

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Vol. 4, No. 2. February, 1927.]

Priestley's Life in Northumberland and Discussion of the Priestley Relics on Exhibition in the Museum

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C. A. Browne, Chief, Bureau of Chemistry,
Washington, D. C.

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[Reprint from the Journal of the American Chemical Society, 49, 1847 (1927).

NEW BOOKS

Old Chemistries. By EDGAR F. SMITH, University of Pennsylvania. McGraw-Hill Book Company, Inc., 370 Seventh Avenue, New York City, 1927. xi + 89 pages, 32 illustrations. 26 × 18.5 cm. Price $2.50.

The chemists who have had the good fortune to read this latest volume by Professor Smith have no doubt been tempted, as was the reviewer, to alter the old familiar motto of Alonzo of Aragon into "Old wood to burn, old wine to drink, old friends to trust and old chemistries to read." It is indeed just such a book as one would delight to discuss with a well-tried friend on a wintry evening when the wood fire is blazing merrily and while there is still left, perchance, a little of the precious vintage of former days.

Those visitors, who have penetrated to the innermost sanctum of Professor Smith's office, with its priceless collection of old chemistries and prints and with its scores of framed portraits of chemists looking down from the walls like a cloud of witnesses, know that there is no more fascinating hobby than the pursuit in leisure hours of the cultural side of one's vocation. Professor Smith's object, as modestly stated in his preface, is "to lay before interested readers a hint of the vast stores of early literature relating to chemistry." The book, however, is more than a hint and might almost be termed an anthology, so varied and so interesting are the selections to which the reader's attention is called. Some fifty authors are cited whose published works extend over a period of three centuries, from an edition of Geber printed at Nuremberg in 1545 down to the "Muck Manual" of Samuel L. Dana, printed at Lowell, Massachusetts, in 1842. In addition to ancient works upon alchemy, there are mentioned old treatises, histories, catechisms, conversations, compendia, epitomes, manuals, systems, elements, essays, lectures, dissertations and philosophies of chemistry—a list so general and comprehensive that every chemist, no matter how specialized, will find much to attract his interest. The references to these volumes are enlivened by the sympathetic comments of the author as he opens his treasures before us and calls our attention to this or that passage or illustration. The company to which the reader is admitted is a select one, including not only European celebrities, such as Black, Bergmann, Fourcroy, Lavoisier, Chaptal, Orfila, Parkes, Thomson and Accum, but early American authors such as Rush, Ewell, Macneven, Gorham, Bache, Silliman, Hare and others. The well chosen illustrations of apparatus, title-pages, lecture cards, chemists, etc., lend additional interest to the volume. There are portraits which, once seen, the reader will never forget, such as the cherub face of Boerhaave and the delightful antique of Mrs. Marcet in lace cap and curls. There are also letters, such as the historic message of Lavoisier to Franklin and the charming congratulatory note of John Adams to Gorham which, once read, will stimulate a second and a third perusal.

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Emerson and Chemistry

BY

CHARLES ALBERT BROWNE

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The Planter and Sugar Manufacturer

Vol. LXXXII NEW ORLEANS, JANUARY 26, 1929 No. 4

X-S 585.56 #4

John Redman Bovell

(Contributed by C. A. Browne.)

The death of Mr. John R. Bovell in the Island of Trinidad on the 10th of last November after a brief illness of nine days, removes one of the pioneer workers in the development of sugar cane seedlings. In view of the great importance of his work on the sugar cane industry, most not only of the British West Indies where his life was spent, but also of the whole world, it is fitting that some reference should be made at this time to his career and accomplishments.

John Redman Bovell was born on December 31, 1855, in Barbados, a son of the late John Bovell and a descendent of a family that has played a long prominent part in the development of the British West Indies. He was educated at Lodge School and Harrison College, Barbados, and obtained his first training as a sugar planter. In 1881 he entered the employment of the government of Barbados, which he continued to serve in various capacities as Superintendent and Director of Agriculture, until the time of his retirement in 1925. In 1891 he was appointed Superintendent of the Botanical Station and it was during the time of this connection that he made his first observations upon the germination of sugar cane seed. His account of the discovery, as narrated to the writer in February, 1919,* was as follows:

Sugar cane seedlings were first discovered in Barbados in May, 1858, by Mr. J. W. Parris, the proprietor of Highland plantation, who wrote an account of the discovery for the local press, with the statement that the seedlings were from Bourbon, Transparent and native canes. While the discovery was contradicted and temporarily forgotten there was nevertheless a tradition established that the seed of the sugar cane, under certain favorable conditions, might germinate. Among those influenced by the work of Parris was Mr. Bovell who, in his search for germinating cane seed, instructed the overseers on the experimental farm at Dodds to inform him if they saw any grass-like plants which they could not recognize. In January, 1888, owing to a rather continuous rainfall, a field of young sugar canes was not weeded for some weeks as the land was too wet, and the consequence that grasses and weeds started to grow freely. As soon as weather conditions permitted Overseer J. H. Pilgrim was sent with a number of boys to weed the field when he noticed a number of strange grass-like plantlets to which he called Mr. Bovell's attention. Sixty-nine of these plantlets were set out in an adjoining field and Mr. Bovell's enterprise was soon repaid by their development into sugar canes. At the close of 1888 Mr. Bovell sowed several boxes with sugar cane spikelets and in a short time was rewarded by seeing a number of them germinate. The reliability of these observations was disputed, however, and it was not until Prof. J. B. Harrison and Mr. Bovell had demonstrated the fertility of cane seed by actual germination tests that all doubts upon the question were removed.

For the British West Indies the discovery of new seedling canes in Barbados in 1888 came at a most opportune time for just after this date the old Bourbon cane, which for centuries had been the chief source of the world's sugar supply, began to decline in vigor and to succumb to the attack of fungus diseases. The yield of cane decreased enormously and the sugar industry of the West India Islands would have been ruined, had the new hardier seedlings, which had been developed, not come to the rescue.

Since the time of his pioneer work upon this subject forty years ago Mr. Bovell was successful in propagating a large number of valuable Barbados sugar cane seedlings and hybrids, several of which, such as the B.H. 10 (12), have proved to be the salvation of the sugar industry not only in Barbados but in other cane producing countries.

Mr. Bovell's self-sacrificing devotion to his cane seedling work in the early days is told in a letter which the writer received from him last September only two months before his death. In mentioning the difficulty of securing financial support for his experiments Mr. Bovell wrote "When I asked Sir William Robinson, the Governor of Barbados, to allow me to carry out the sugar cane experiments and informed him that Harrison was willing to help, he informed us that we could carry them out but that we must not ask for any money and so I had for some time to buy a quantity of chemical, botanical and biological apparatus; and for years I had, in addition, to pay an assistant out of my salary." It is doubtful if greater benefits were ever derived by any country from so complete a lack of support for initial experimentation than was realized by the British West Indies in the case of the new sugar cane seedlings.

In the course of his long active career Mr. Bovell was instrumental in serving the cane growing interests of many other localities besides Barbados. He went to Antigua in 1890 to start the Skerrett's Training School; in 1899 he went to Antigua and St. Kitts to initiate sugar cane experiments; he was sent to St. Vincent to report on the damage done by the volcanic eruptions of 1902-3 and 1907; he went to Porto Rico in 1909 to report on the sugar cane diseases occurring on a number of sugar plantations; in 1910 he was invited to St. Croix by its governor to formulate a scheme for a department of agriculture for that colony which was then under Danish control—a service that led to the establishment of the St. Croix Experiment Station; in 1917 he went to Guadeloupe and Marthinique, at the request of their governors and with the permission of the Governor of Barbados, to report on the sugar industry of these two islands, a service which led to the establishment of an agricultural experiment station in Guadeloupe. His advice upon the agriculture of sugar cane was also sought by the Governments of St. Domingo and Jamaica.

Mr. Bovell's interest in tropical agriculture was not limited to the sugar cane but extended to a large number of other crops. He was greatly interested in the cotton industry of his colony and during the writer's visit at his home at Codrington House in Barbados in 1919 he exhibited various strains of Sea Island Cotton which he had developed that were of a quality superior to that grown in the United States.

Mr. Bovell was awarded the Imperial Service Order in 1908 for his distinguished work in tropical agriculture. He will long be remembered not only for his outstanding accomplishments but for his unfailing kindness, courtesy and loyalty to every movement for the promotion of the public welfare.

Since his retirement as Director of Agriculture in Barbados in 1925 Mr. Bovell made his home at Paradise House, Tacarigua, Trinidad. His remains were placed in the family vault in Barbados on November 27, 1928. He is survived by his widow Mrs. Louisa Bovell and a son, to both of whom the sympathy of a host of friends in all parts of the world is extended.

*Presented in THE PLANTER AND SUGAR MANUFACTURER, Vol. 63, pages 170-174, September 13, 1919.

Estimation of Alcohol

Experiences Upon Attempts to Obtain Distillates of "Pure Ethyl Alcohol" in the Analysis of Commercial Alcoholic Preparations, by William L. O. Whaley, Assistant Chemist, Prohibition Laboratory, Internal Revenue Service, New Orleans, La.

Part 1

Introduction, Purpose and Explanations

One of the simplest determinations made in analytical procedures is that of the estimation of alcohol. The necessary steps are only to distill off the alcohol from interfering substances into a known volume of water and determine the amount of alcohol in this distillate, calculating this value to the original volume of material from which the alcohol was obtained. Nothing could be simpler than the foregoing. The difficulty arises, though, in following the outline.

The number and variety of selections that might be secured from the stream of samples flowing to our laboratories for comparing and investigating such findings as those presented appears infinite. The list embraces face lotions, metal polishes, dentifrices, insecticides, tonics and grape nectars. To the foregoing add photographic developers, flavoring extracts,

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A FEW IMPRESSIONS OF AGRICULTURAL CHEMISTRY IN FOREIGN COUNTRIES

BY

C. A. BROWNE

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Journal of the Association of Official Agricultural Chemists
February 1931

THE SPONTANEOUS HEATING OF HAY

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Radio talk on the National Grange Program, Farm and Home hour, broadcast Saturday, June 20, 1931 over WRC and 43 associated stations of the National Broadcasting Company.

By

C. A. Browne,
Bureau of Chemistry & Soils,
U. S. Department of Agriculture,
Washington, D.C.

The spontaneous heating of hay in barns and stacks is a subject which has aroused the interest of farmers from the time when primitive man first attempted to store grass in his prehistoric cave. It has been a general observation among all races of mankind that hay, when piled in large masses, frequently begins to heat and in certain cases will actually catch fire.

The annual losses resulting from the burning of barns and other farm property in the United States as a result of spontaneous combustion have been estimated, to be at least $20,000,000 a year, which is 20 per cent of the total estimated annual loss of $100,000,000 from fires on farms. But if we consider in addition the decreases in weight and in nutritive value which hay undergoes during spontaneous heating, in the more general cases where there is no actual outbreak of fire, the losses will amount to many times this sum.

The total hay crop of the United States has an estimated annual value of some thirteen hundred million dollars ($1,300,000,000). The results of a careful conservative estimate lead to the conclusion that at least one-tenth of our harvested grass crop, from the time it is cut until it is used, is lost as a result of spontaneous heating, —as surely lost and consumed as if our farmers had consigned every tenth load of their harvest to the flames. A thorough understanding of the causes of this great loss and the development of suitable means for its prevention are, therefore, matters of the greatest practical importance. They are subjects to which the scientists of the Department of Agriculture are at present devoting much attention.

/ The spontaneous heating of hay takes place in three stages. The first stage is due to the vital activities of the living cells of the grass which continue for some time after it is cut. As a result of these cellular processes the sugars and other carbohydrates of the grass begin to be broken down and heat is evolved. This heat is rapidly carried away and is not sensible to the touch, if there is free circulation of the air. If, however, the freshly cut grass be placed in a pile, the escape of heat is retarded and it immediately becomes perceptible upon insertion of the hand.

When the mass of heating hay reaches a temperature of about 110°F. the life of the grass cells is destroyed and there then commences the second period of the spontaneous heating which is due to the activities of the moulds and bacteria that occur naturally in hay. The numbers of these micro-organisms, because of the favoring warmth and moisture produced in

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OBITUARY OF CLIFFORD RICHARDSON

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November, 1932

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SPECIAL APPLICATIONS IN METHODS OF AGRICULTURAL CHEMICAL ANALYSIS

BY
C. A. BROWNE

Reprinted from
Journal of the Association of Official Agricultural Chemists
February, 1932

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[Reprinted from Journal of Chemical Education,
Vol. 9, No. 4. April, 1932.]

The History of Chemical Education in America between the Years 1820 and 1870

C. A. Browne, U. S. Department of Agriculture, Washington, D. C.

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[Reprinted from Journal of Chemical Education,
Vol. 9, No. 10. October, 1932.]

An Early Experiment of James Woodhouse upon the Synthetic Production of Ammonia

Charles Albert
C. A. Browne, Bureau of Chemistry and Soils, U. S. Department
" of Agriculture, Washington, D. C.

Form card

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THE SPONTANEOUS HEATING AND IGNITION OF HAY AND OTHER AGRICULTURAL PRODUCTS

C. A. BROWNE
U. S. BUREAU OF CHEMISTRY AND SOILS

Reprinted from SCIENCE, March 3, 1933, Vol. 77, No. 1992, pages 223–229.

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PRODUCTION AND USE OF POTASH

By C. A. Browne
Assistant Chief, Bureau of Chemistry and Soils, U. S. Department of Agriculture

Reprinted from
Proceedings of the Eleventh Annual Convention of
The National Fertilizer Association, 1934-35

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REPORT ON SUGARS AND SUGAR PRODUCTS

BY

C. A. BROWNE

Reprinted from
Journal of the Association of Official Agricultural Chemists
May, 1935

C. A. Brown

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.B8 #54

OUR CHEMICAL HERITAGE

AMERICAN CHEMICAL
INDUSTRIES TERCENTENARY
1635—1935

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X-S 585.B6 #55

THE OCCURRENCE OF THE METHOXYL, ETHOXYL, AND METHYLENE DIOXIDE GROUPS IN SUBSTANCES OF VEGETABLE ORIGIN AND A POSSIBLE EXPLANATION OF THE MECHANISM FOR THEIR FORMATION BY THE PLANT

C. A. BROWNE AND MAX PHILLIPS

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JOURNAL OF THE WASHINGTON ACADEMY OF SCIENCES
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Charles Albert Browne

THE first twenty-two years of Browne's life were spent in the Berkshire Hills in Massachusetts. He was born at North Adams on August 12, 1870. A very short time before this his father had lost his eyesight as a result of an explosion in his laboratory, and Browne's earliest recollections are connected with his companionship and help to his father. From his early youth he spent much time reading to his father and assisting him in his experiments. Before Browne was ten years old, he was accustomed to read to his father regularly, especially from Fowne's Chemistry, Ure's Dictionary of Arts, Manufactures, and Mines, and the *Scientific American*. At first he could understand little of what he read, but the experience taught him to read rapidly and well. As he grew older the discussion of these articles with his father assisted in developing his faculty of grasping the full significance of what he read and remembering it thereafter—a faculty which he has developed to a very unusual extent.

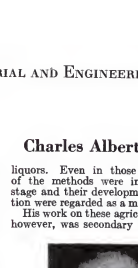
Browne's father was an inventor—a self-made man—who took out many patents relating to blasting operations, especially patents on explosives and electric exploders. He had much experience with railroad construction and had charge of the blasting operations, for instance, in the Hoosac Tunnel. It was his exploder that was used to blow up Hell Gate in later years. Although without training in chemistry, the father was a diligent student and acquired an extensive knowledge of the branches of chemistry in which he was particularly interested, especially the chemistry of explosives.

In his early years Browne assisted in the work on his grandfather's farm (adjoining his own home), and there had experience that influenced the first years of his professional life. He leached wood ashes and dried the leachings for the manufacture of soft soap and participated in the manufacture of vinegar, cider, maple sirup, cheese, and butter.

Browne graduated from Williams College in 1892 and immediately obtained employment in a commercial laboratory in New York City, where he spent two years in analytical work of the most miscellaneous nature. Then, for something more than a year, he was instructor in chemistry at the Pennsylvania State College, where his spare time was occupied in the study of organic synthesis under the direction of Tuttle. His work as a teacher was interrupted by an illness of several months owing to experimental work with hashish. His convalescence was spent at his home in North Adams, where he increased the laboratory facilities in the woodshed adjoining the house and devoted much time as he was able to the synthesis of diazo dyestuffs.

In the late spring of 1896, he was appointed assistant chemist of the Pennsylvania Experiment Station, which position he held until 1900. There he thoroughly familiarized himself with the knowledge then available regarding the chemistry, and especially the analysis, of agricultural products and feeding stuffs. At that time the field of agricultural and food analysis was very narrow and restricted as compared with the present day. The methods of the Association of Official Agricultural Chemists were limited to fertilizer analysis, sugar analysis, stock feeds, dairy products, and fermented and distilled liquors. Even in those subjects many of the methods were in the formative stage and their development and adaptation were regarded as a major problem.

His work on these agricultural methods, however, was secondary to research projects started during the early days of his connection with the Experiment Station. This work included the study of the composition of apple cider, cider vinegar, and of changes in the composition of apples in connection with the manufacture of such products. It also included a chemical study of butter with special reference to the question of rancidity, a field in which he has ever since retained his interest and made the subject of occasional research. He also assisted Armsby in the development of his respiration calorimeter for animals, and did much analytical work in the examination of the feeds employed by Armsby and of the products of metabolism of the animals.



CHARLES ALBERT BROWNE

He became greatly interested in the determination of sugar in apples, apple cider, sugar beets, etc., and in the study of the insoluble carbohydrates of the feeds used in connection with the respiration calorimeter, and was especially impressed with the importance of research relating to the carbohydrates. The next two years, therefore, were devoted to this subject at the University of Göttingen. His most noteworthy work there was the study of the insoluble carbohydrates of corn pith which formed the basis of his inaugural dissertation. In 1902 he received the degree of Ph.D. in Göttingen, and the same year was appointed research chemist of the Louisiana State Sugar Experiment Station, then located in New Orleans, which position he held until 1906. Here he studied both the soluble and insoluble carbohydrates of the sugar cane and gave much attention to rice bran, especially with reference to the rancidity and utilization of its oil.

Browne was chief of the Sugar Laboratory of the United States Bureau of Chemistry in 1906 and 1907, and was chemist in charge of the New York Sugar Trade Laboratory from 1907 to 1923. In the latter position Browne's primary responsibility was the management of a ceaseless flow of routine work. He so organized it, however, that his time and energy were chiefly devoted to research, which extended over the entire field of the chemistry, production, and storage of sugar, and contributed much to the available information on the subject. His work on the cause and prevention of the decomposition of raw sugar during storage was of exceptional scientific interest and of great value to the industry.

His interest in this work was so great and his relations with all with whom he came in contact so pleasant that it was with the greatest regret that he severed his connection with the Sugar Trade Laboratory in 1923 to become chief of the Bureau of Chemistry of the United States Department of Agriculture. In accepting this position he looked forward to an opportunity for a broad range of research in agricultural chemistry. He hoped so to organize the work of the bureau that he would be able to give his personal attention to its research problems, rather than its executive and routine work. In this he was not so successful as he had hoped, for he found it necessary to give much more of his personal attention to the executive work of the bureau than he desired. Nevertheless, he was able to enter actively into the whole range of research work of the bureau and contributed largely to its planning and development.

In 1927, when the reorganization of the Department of Agriculture combined the Bureau of Chemistry and the Bureau of Soils, Browne wished to be relieved of the administrative duties which he felt had interfered with the field of work in which he was chiefly interested and for which he was particularly qualified, and he refused the position of chief of the combined Bureau of Chemistry and Soils which was tendered him. He did accept the position of acting chief of the bureau until a permanent chief was appointed, after which he became assistant chief of the bureau and chief of Chemical and Technological Research of the Bureau of Chemistry and Soils, which position he retained until 1935. Then, at his urgent request, he gave up that office in order that he might be still further freed of administrative work and was appointed supervisor of chemical research.

While in the Pennsylvania Experiment Station, Browne began a series of contributions to the literature of chemistry which has continued with increasing frequency to the present time. His articles have appeared for the most part in the journals of the AMERICAN CHEMICAL SOCIETY, but many of them have been printed in a wide range of other publications. During this period his original papers were related to the chemistry of agricultural products, particularly the apple and its products, the analysis of feeding stuffs, and the chemical composition of butter fat, with special reference to its rancidity.

The reports of his researches on sugar, which began in his early days in the Sugar Trade Laboratory and extend to the present time, are an important part of the literature of carbohydrates. While in that laboratory, also, he published his "Handbook of Sugar Analysis" and his "Sugar Tables for Laboratory Use."

Since his connection with the Bureau of Chemistry, his writings have covered a much broader field. His articles on the history of chemistry, begun while at the New York Sugar Trade Laboratory, have greatly increased in frequency and he has long been recognized as the foremost writer on the subject in this country. Some of his historical treatises, as for instance, "The Early History of Chemical

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OBITUARY—SAMUEL PALKIN

BY
C. A. BROWNE AND L. A. GOLDBLATT

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OBITUARY—CHARLES WILLIAM DABNEY

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C. A. BROWNE

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CHEMICAL REPRINTS OF C. A. BROWNE

1936 --- 1940

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Roscoe Edward Doolittle

1874-1926

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THE VERIFICATION OF THE 100° POINT OF THE VENTZKE SUGAR SCALE

By C. A. BROWNE (Bureau of Chemistry and Soils, Washington, D. C.).

#62

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Frederick Belding Power

1853-1927

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The Deterioration of Raw Sugar Samples.

(By Dr. C. A. Browne.)

Numerous references which have been made, in the columns of THE LOUISIANA PLANTER and elsewhere, to the results upon the deterioration of raw sugar samples, published in my report of the New York Sugar Trade Laboratory for 1914, show that my figures have been subjected, in several cases, to a wrong interpretation.

I have been quoted, for example, as indicating "that all or practically all sugars deteriorated in storage," when, as a matter of fact, I have made no such statement. The experiments, upon which my results were based, were all made upon sugar samples in sealed glass jars and it is not permissible to conclude from observations made under these conditions that the same things necessarily happen to sugars stored in bags in a ware-house.

Deterioration may, and frequently does, occur in sugar samples when no evidences of deterioration can be detected in the stored sugar from which these samples were drawn. This can be explained as due to the infection which the sugar samples receive from the implements and hands of the samplers and mixers.

On the other hand, deterioration of stored sugar in the warehouse may not be attended by deterioration in the samples; the warehouse may be leaky or there may be conditions of atmospheric humidity which would cause deterioration of sugar in a bag, but not in a sealed bottle. As an illustration of this we need only to quote some results obtained by Strobmer* in 1893 upon the storage of beet sugars.

Strobmer's results show that the sealed sugar samples and the sugar in dry storage undergo but little change in composition, whereas the sugar in damp storage suffers a marked deterioration. The fluctuations of the latter in moisture are particularly noteworthy, there being an absorption of over 4 per cent moisture during the first 3 months of storage.

A deterioration of sugar in the sample bottle may be taken, however, as an index of what may occur in the warehouse and if his results are controlled by check experiments the chemist can usually determine whether the deterioration of the sample is due to bad sugar or to accidental infection during sampling. As an example, I will cite a case from our experiments of 1914 where two marks of sugar of similar polarizaton were sampled upon the same day by the same samplers from the same cargo:

TABLE II.

	June.	October.	Loss.
		Mark A. Polarization.	
Sample 1	97.10	94.30	—2.80
" 2	97.30	96.10	—1.20
" 3	97.25	93.50	—3.75
" 4	97.20	95.70	—1.50
		Mark B. Polarization.	
" 1	97.15	97.05	—0.10
" 2	97.35	97.30	—0.05
" 3	97.35	97.45	+0.10
" 4	97.30	97.10	—0.20

TABLE I.

Sugar in Sealed Glass Bottles.

Time of Analysis.	Polarization.	Water.	Ash.	Foreign. organic.	Invert sugar.	Alkalinity.
At beginning	95.3	1.71	1.29	1.70	0.00	0.033
After 3 months	95.4	1.70	1.30	1.60	0.00	0.026
After 12 months	95.5	1.67	1.30	1.53	0.00	0.020
After 18 months	95.4	1.50	1.31	1.79	0.00	0.020

Sugar in Bags in a Dry Storage Room.

Time of Analysis.	Polarization.	Water.	Ash.	Foreign. organic.	Invert sugar.	Alkalinity.
At beginning	95.3	1.71	1.29	1.70	0.00	0.033
After 3 months	95.7	1.29	1.30	1.71	0.00	0.018
After 12 months	95.2	1.67	1.30	1.83	0.00	0.014
After 18 months	95.1	1.71	1.28	1.91	0.00	0.010

Sugar in Bags in a Damp Storage Room.

Time of Analysis.	Polarization.	Water.	Ash.	Foreign. organic.	Invert sugar.	Alkalinity.
At beginning	95.3	1.71	1.29	1.70	0.00	0.033
						Neutral
After 3 months	91.0	5.98	1.06	1.96	0.06	
						Acidity
After 12 months	87.3	2.39	0.34	9.97	0.93	0.021
After 18 months	85.7	3.03	0.38	10.89	1.09	0.025

* Strohmer, Oesterreichisch-Ungarische Zeitschrift fur Zuckerindustrie, Vol. 22 (1893) pg. 216.

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THE DETERMINATION OF REDUCING SUGARS FROM THE WEIGHT OF CUPROUS OXIDE.

By C. A. Browne,

(Chemist-in-Charge, New York Sugar Trade Laboratory).

From the recent articles by Zerban and Naquin and by Walker in the *International Sugar Journal* it would seem that the use of the Neubauer crucible depends entirely upon whether the copper is to be weighed as Cu_2O or as CuO. The increase in weight noted by Zerban and Naquin in weighing the copper as Cu_2O may perhaps be due to a slight oxidation of the Cu_2O when in contact with the spongy platinum. This phase of the discussion, however, is a minor one in comparison with the main point, which is, that in the determination of reducing sugars in commercial products the copper should never be weighed as Cu_2O when accuracy is desired. Weighing as Cu_2O may give correct results in the case of pure sugars and products of high saccharine purity, but the danger of contamination with organic and mineral matter is too great when other materials than those of a carbohydrate nature are present. This fact, which was emphasized by the writer in his reports as Referee upon Sugar for the Association of Official Chemists in 1906 and 1907, and again referred to by Zerban and Naquin in their recent paper, seems to have been entirely overlooked by Mr. Walker in his reply to Zerban and Naquin's article.

To show the extent of the error which may result from determining the copper as Cu_2O in certain products the writer quotes the following figures by Sherwood and Wiley from his report in the Proceedings of the Association of Official Chemists, 1906, page 120 :—

Material.	Reduced Copper. From weight of cuprous oxide. Gram.	Reduced Copper. From weight of cupric oxide. Gram.	Volumetric method (Low) Gram.
Molasses residuum	0·3753	0·3594	0·3494
Ditto	·3905	·3634	·3470
Ditto..	·2517	·2348	·2242
Ditto	·3287	·3130	·3034
Ditto..	·3291	·3134	·3029
Ditto	·2768	·2698	·2688
Ditto..	·2709	·2620	·2612
Pure dextrose	·4619	——	·4617
Ditto..	·2449	——	·2444
Ditto	·1251	——	·1257
Beer	·0755	——	·0753
Ditto	·0746	——	·0748
Molasses	·4628	——	·4520
Corn juice	·3360	——	·3134
Malt extract	·3322	——	·3048
Ditto	·3160	——	·2933
Ditto..	·2093	——	·1934

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Justus von Liebig—Man and Teacher
Liebig and the Law of the Minimum

By
CHARLES ALBERT BROWNE

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